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COMMISSIO 31: TIM
(T M S)

1. Appointment of O±cials for 2000-2003

Drs. G. Petit and D. Matsakis have been elected as the President and Vice President of the Commission for the next term, 2000-2003, respectively. As for the Organizing Committee Members, we welcome D. Matsakis as a new member and appreciate the outgoing members, Drs Brumberg, Fliegel, Luck, Paquet, and Thomas, for their contributions and e®orts. Also T. Fukushima was nominated as the IAU Representative to the CIPM/CCTF for the next triennium.

2. Report of the BIPM Time Section (communicated by F. Arias)

Reference time scales International Atomic Time (TAI) and Universal Coordinated Time (UTC) have been computed regularly and have been published in the monthly Circular T. De¯nitive results for 1997, 1998 and 1999 have been available, in the form of computer-readable ¯les in the BIPM home-page and on printed volumes of the respective Annual Reports of the BIPM Time Section. The printed version of the last volume has been substantially shortened with the aim to progress to an electronic version in the next future. Work is done to automate the calculation of TAI and UTC, this allowing a shorter delay in the publication of Circular T.

Research concerning time scale algorithms includes studies to improve the long-term stability of the free atomic time scale EAL and the accuracy of TAI. Studies are undertaken to evaluate the feasibility of providing a prediction of UTC in quasi-real time. Some 80 % of the clocks are now either commercial caesium clocks of the type HP5071A or active, auto-tuned active hydrogen masers, and together they contribute 86 % of the total weight with consequent improvement in the stability of EAL. Since most HP5071A clocks have at present the maximum relative weight, the weighting procedure of clocks in TAI is under revision. The medium-term stability of EAL, expressed in terms of the Allan deviation, is estimated to be $0{:}6 \pounds 10^{-15}$ for averaging times of 20 to 40 days over the period. Nine primary frequency standards reported their measures to the BIPM. The global treatment of these individual measurements led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid ranging, in the last year, from $+0{:}2 \pounds 10^{-14}$ to $+0{:}6 \pounds 10^{-14}$, with an uncertainty of $0{:}4 \pounds 10^{-14}$. Following the recommendations of the Consultative Committee on Time and Frequency, changes were implemented to render the data used in TAI, as well as the results, more accessible to the users and to make the procedures of calculation even more transparent and traceable. Since April 2000 two modi¯cations were implemented: a new model to characterise the instability of the free atomic scale EAL, and a more complete representation of the uncertainty of the deviation of the TAI scale interval relative to that of the Terrestrial Time TT.

In the last decade the time links computed at the BIPM used the classical GPS common-view technique based on C/A-code measurements obtained from one-channel re-

ceivers. The commercial availability of newly developed receivers has stimulated interest in extending the classical common-view technique for use of multichannel dual-code dual-system (GPS and GLONASS) observations, with the aim of improving the accuracy of time transfer. The two-way time transfer via geostationary satellites (TWSTFT) proved to be potentially better that GPS. Since July 1999 GPS multichannel links and TWSFTF links are being progressively introduced in TAI. In addition, the BIPM Time section carries on testing other time and frequency comparison methods, such as phase measurements . Ionospheric parameters and precise ephemerides provided by the IGS (International GPS Service) are now routinely used to correct all links in regular TAI calculations.

The BIPM/IAU Joint Committee on general relativity for space-time reference systems and metrology (JCR), created in 1997, continued its work. Two studies have been conducted at the BIPM in collaboration with other members of the JCR. One concerns the extension of the relativistic framework to allow a correct treatment for time transformations and the realisation of barycentric coordinate time at the full post Newtonian level. The second study concerns the realisation of geocentric coordinate times. Following a Call for Participation of the IERS, the BIPM, jointly with the USNO, will provide its Conventions Product Centre since January 2001.

3. Report of USNO Time Serivice Dept. (communicated by D. Matsakis)

The U.S. Naval Observatory (USNO) Time Service Department has a real-time mission to keep the USNO Master Clock as stable and as close to UTC as possible, and to disseminate its time via GPS and other means, such as Two-Way Satellite Time Transfer (TWSTT) and Loran. To achieve the required stability and robustness, we maintain a large ensemble of clocks - about 65 HP5071 cesiums and 15 cavity-tuned Datum masers, distributed in three buildings at two sites, kept in environmentally benign conditions, and intercompared using state-of-the-art measurement systems.

Although most of our 28-person sta® is involved with maintaining the hardware, software, and data °ow needed for our operations, we are also ¯nding ways to improve things. We are about to switch to a more stable and robust measurement system; have recently improved our clock steering algorithms; are testing steering algorithms that are better still; are constructing improved chambers to house our clocks; are developing better GPS receivers; have improved timescale and clock-characterization algorithms; are building atomic fountains; and are purchasing trapped-ion mercury clocks from Lute Maleki's group at Jet Propulsion Laboratory (JPL).

The driver for many of our upgrade plans is the anticipated needs of speci¯c users, among them GPS. But it is also worthy of note that we cannot do it alone. We need the help of the timekeeping community, and we are seeking to improve cooperation in many ways. To help improve the short-term stability of TAI, we are cooperating with the BIPM in making TWSTT the operational mode for TAI generation, and are interested in improving TWSTT technology through carrier-phase receive systems and more stable hardware. Another very exciting mode of time transfer is carrier-phase GPS. Under the leadership of the BIPM and the IGS, we are again working on improvements to both the software and hardware. With Allan Osborne Associates we have found a hardware ¯x that promises to make their widely used receivers calibratable and robust in a timekeeping sense; with Ron Muellerschoen of JPL we have developed a continuous Kalman ¯lter so that day-boundary processing discontinuities can be avoided; with data from many IGS sites created and published a frequency scale based only on GPS carrier-phase data; and with Joe White and Ron Beard of Naval Research Laboratory (NRL) we are conducting absolute calibration studies on many hardware components.

Toshio Fukushima
President of the Commission